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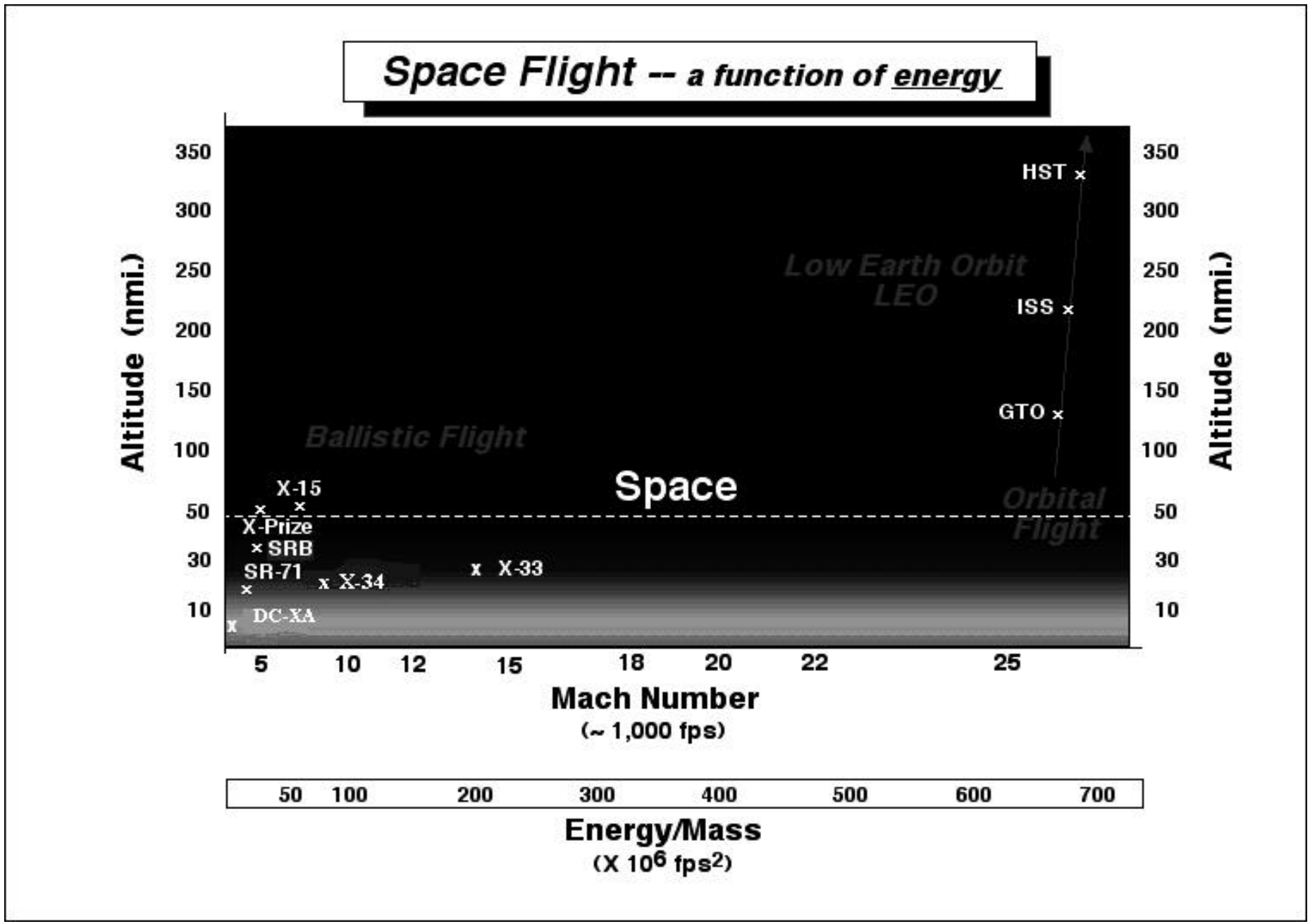
# Shuttle/RLV/Commercial Transport Aviation
# Historical Perspective & Background


Space Flight -- a function of energy
Altitude (nmi.)
350
300
250
200
150
100
50
30
10
Low Earth Orbit
LEO
HST
ISS
GTO
Ballistic Flight
Space
Orbital
Flight
X-15
X-Prize
SRB
SR-71
X-34
X-33
DC-XA
5
10
12
15
18
20
22
25
Mach Number
(~ 1,000 fps)
50
100
200
300
400
500
600
700
Energy/Mass
(X 10^6 fps^2)

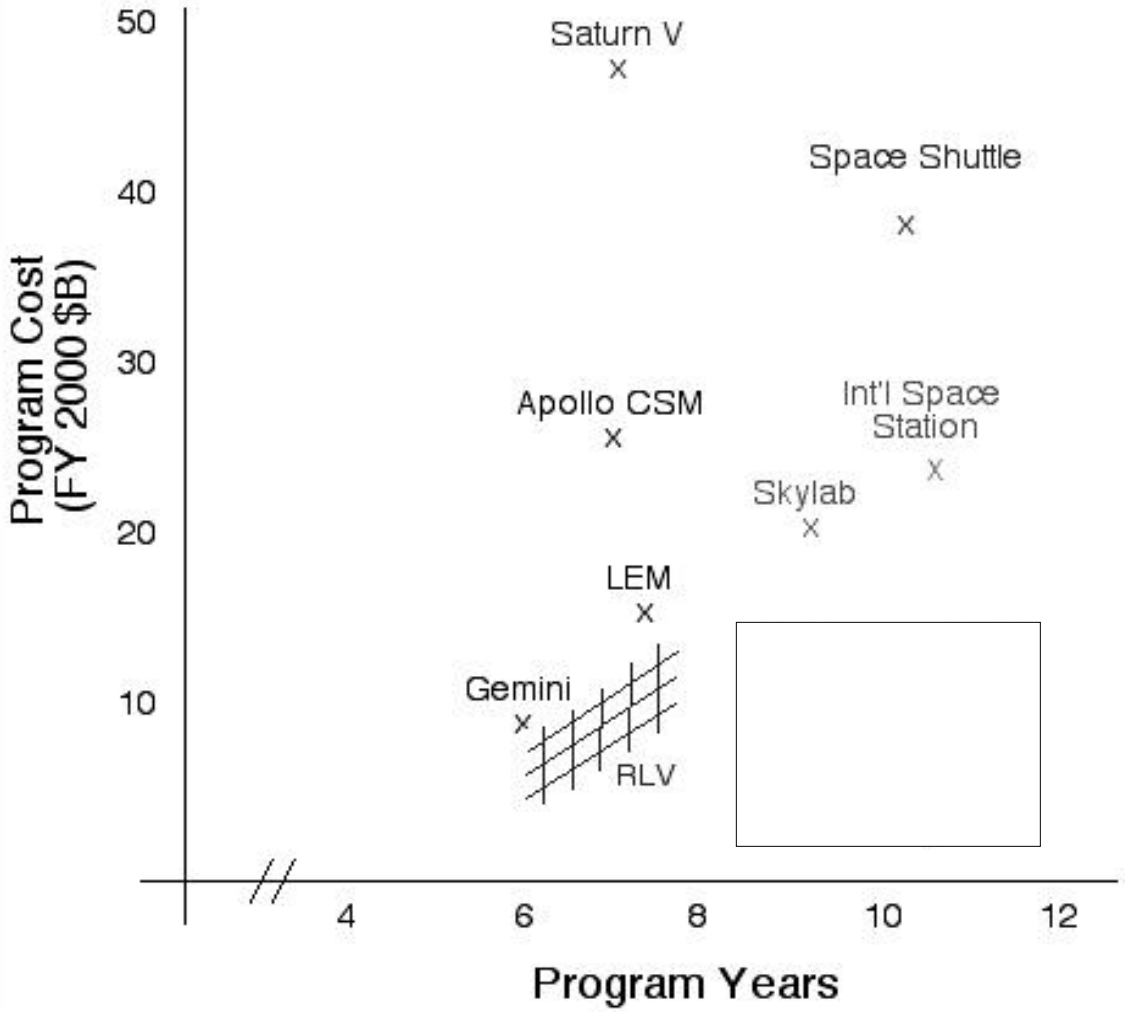
# Why is the Space Shuttle so ‘complex’?

Unlike an Expendable Launch Vehicle (ELV)
whose lifetime is less than an hour from lift off to reentry,

The Shuttle is:
A human-rated rocket ship for eight-and-a-half minutes,
A spacecraft for ten days to two weeks,
    a habitable research platform, capable of rendezvous, docking,
    deploying, retrieving, repairing and
    supporting spacewalks for space construction,
A hypersonic reentry vehicle for an hour,
A piloted subsonic glider for about five minutes.

The Shuttle is certified for 100 missions,
 each lasting from five days to almost three weeks duration.

# Historical Program Cost



Six and a half Airliner Generations

| | | | | |
|---|---|---|---|---|
| Wright Flyer | 1903 | 1 ‘seat’ | 40 mph | fabric/wood |
| Ford Trimotor | 1927 | 12 seats | 110 mph | aluminum |
| DC-3 | 1933 | 21 seats | 180 mph | aerodynamic |
| DC-7 | 1953 | 105 seats | 360 mph | supercharged |
| Boeing 707 | 1954 | 147 seats | 550 mph | turbojet |
| Boeing 747 | 1969 | 385 seats | 550 mph | turbofan, wide-body |
| Concorde | 1969 | 144 seats | 1350 mph | supersonic mach 2.05 |
| Boeing 767 | 1981 | 211 seats | 550 mph | twin-jet, glass cockpit |
| Boeing 777 | 1994 | 360 seats | 550 mph | fly-by-wire |

First Generation Reusable Launch Vehicles

Space Shuttle 1981

When will the next generation happen?

What will the next generation look like?

# Order of Magnitude Analysis

Shuttle

3-4 Flights a year

Depot Maintenance every 10 Missions

100 Mission Design Life/?? Years

Airliner

1000 Flights a year/3500 Hours a year

Detailed Structural Inspection every 25,000 Hours

25,000 Mission Design Life/20 Years